

## 5.16.06 SPECIFIC GRAVITY AND ABSORPTION OF AGGREGATES (Kansas Test Method KT-6)

### **a. SCOPE**

This method of test covers the procedures for determining the specific gravity and absorption of aggregates. Coarse aggregate (Procedure I) represents aggregate retained on the 4.75 mm (No. 4) sieve. Fine aggregate (Procedure II) is all aggregate passing the 4.75 mm (No. 4) sieve. KT-6 reflects testing procedures found in AASHTO T 84 and T 85.

### **b. REFERENCED DOCUMENTS**

**b.1.** KT-1; Sampling Aggregates

**b.2.** KT-11; Moisture Tests

**b.3.** KT-24; Determination of Free Moisture or Absorption of Aggregate for Use in Concrete

**b.4.** AASHTO M 92; Wire-Cloth Sieves for Testing Purposes

**b.5.** AASHTO M 231; Balances Used in the Testing of Materials

**b.6.** AASHTO T 84; Specific Gravity and Absorption of Fine Aggregate

**b.7.** AASHTO T 85; Specific Gravity and Absorption of Coarse Aggregate

**b.8.** ASTM C 128; Test Method for Specific Gravity and Absorption of Fine Aggregate

**b.9.** ASTM C 670; Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

### **c. PROCEDURE I: COARSE AGGREGATE**

#### **c.1. Apparatus**

**c.1.a.** The balance shall conform to the requirements of AASHTO M 231 for the class of general purpose balance required for the principal sample mass of the sample being tested.

**c.1.b.** Bucket approximately 200 mm (8 in) in diameter and 200 mm (8 in) in height.

**c.1.c.** Container with overflow for immersing the bucket in water.

**c.1.d.** Drying oven capable of maintaining a uniform temperature of  $110 \pm 5^{\circ}\text{C}$  ( $230 \pm 9^{\circ}\text{F}$ ).

**c.1.e.** Drying pans.

**c.1.f.** Absorbent cloth.

**c.1.g.** Standard 4.75 mm (No. 4) sieve meeting AASHTO M 92.

**c.2. Test Method**

**c.2.a.** Sample Preparation: This test is normally conducted on the portion of the aggregate that passes the 50 mm (2 in) sieve and is retained on the 4.75 mm (No. 4) sieve. If the test is conducted on larger size particles, it shall be so noted on the test report.

**c.2.a.1.** Select a portion of the aggregate by splitting or quartering as specified in **KT-1**. The minimum mass of the sample, all of which passes the 50 mm (2 in) sieve and is retained on the 4.75 mm (No. 4) sieve, shall be as set out in the following table:

**Table 5.16.06-1**  
Minimum Sample Size for Coarse Aggregate

Sieve Size <sup>a</sup>	Minimum Mass of Samples (g)
37.5 mm (1 1/2 in) or more .....	5,000
25.0 mm (1 in) .....	4,000
19.0 mm (3/4 in) .....	3,000
12.5 mm (1/2 in) or less .....	2,000

**NOTE a:** To select the sample size, use the largest sieve on which 5 percent or more of the material is specified to be retained.

**c.2.a.2.** Thoroughly wash<sup>1</sup> the sample over the 4.75 mm (No. 4) sieve to remove dust and other adherent coatings.

**c.2.a.3.** Dry the sample to a constant mass in the oven<sup>b</sup>.

**NOTE b:** If the absorption and specific gravity values will be used as a basis for the design of concrete mixes where the aggregates are used in a moist condition, this drying procedure may be eliminated. For an aggregate that has been in contact with water and that has free moisture on the particle surfaces, the percentage of free moisture can be determined by deducting the absorption from the total moisture content determined by **KT-11**. Free moisture can also be calculated as described in **KT-24**.

**c.2.b. Procedure.**

**c.2.b.1.** Immerse the sample in water<sup>2</sup> and stir vigorously. Soak for a period of  $24 \pm 4$  hours.

**c.2.b.2.** Remove the sample from the water and bring to a saturated surface-dry condition by rolling the sample in a dampened, absorbent cloth. (For the purpose of this test, a saturated surface-dry condition of the aggregate has been reached when the particle surface appears to be moist but not shiny.)

<sup>1</sup> AASHTO T 85 requires dry sieving and then thoroughly wash to remove dust or other coatings from the surface.

<sup>2</sup> AASHTO T 85 requires the sample to be dried to constant mass prior to immersing in water for a period of 15 to 19 hours.

**c.2.b.3.** Weigh the sample immediately after obtaining the saturated surface-dry condition. All masses determined in this test shall be to the nearest 1 g or 0.1 percent of the sample mass, whichever is greater.

**c.2.b.4.** Immediately after obtaining the saturated surface-dry mass, immerse the sample in water, stir to remove any entrapped air and weigh. The water temperature shall be  $25 \pm 1^{\circ}\text{C}$  ( $77 \pm 2^{\circ}\text{F}$ )<sup>3</sup>.

**c.2.b.5.** Dry the sample to a constant mass at a temperature of  $110 \pm 5^{\circ}\text{C}$  ( $230 \pm 9^{\circ}\text{F}$ ).

**c.2.b.6.** Cool the sample to room temperature and determine the mass.

### **c.3. Calculations**

$$\text{c.3.a. Bulk Specific Gravity} = \frac{A}{B - C}$$

$$\text{c.3.b. Bulk Specific Gravity Saturated Surface-Dry Basis} = \frac{B}{B - C}$$

$$\text{c.3.c. Apparent Specific Gravity} = \frac{A}{A - C}$$

$$\text{c.3.d. Absorption (\%)} = \frac{100 (B - A)}{A}$$

Where: A = Mass of oven-dry sample in air, g

B = Mass of saturated surface-dry sample in air, g

C = Mass of saturated sample in water, g

## **d. PROCEDURE II: FINE AGGREGATE**

### **d.1. Apparatus.**

**d.1.a.** The balance shall conform to the requirements of AASHTO M 231 for the class of general purpose balance required for the principal sample mass of the sample being tested.

**d.1.b.** Volumetric flask of known mass having a minimum capacity of 500 mL and calibrated to within:

1. 0.10 mL at  $25^{\circ}\text{C}$  ( $77^{\circ}\text{F}$ ) for a 500 mL flask.
2. 0.20 mL at  $25^{\circ}\text{C}$  ( $77^{\circ}\text{F}$ ) for a 1,000 mL flask.

**d.1.c.** Not less than two drying pans with bottoms that are slightly rusted.

**d.1.d.** Drying oven capable of maintaining a uniform temperature of  $110 \pm 5^{\circ}\text{C}$  ( $230 \pm 9^{\circ}\text{F}$ ).

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<sup>3</sup> AASHTO T 85 requires the water temperature to be  $23 \pm 1.7^{\circ}\text{C}$  ( $73.4 \pm 3^{\circ}\text{F}$ ). Changing the temperature to  $25 \pm 1^{\circ}\text{C}$  ( $77 \pm 2^{\circ}\text{F}$ ) establishes a uniform temperature requirement on all water bath test-related procedures.

**d.1.e.** Water bath having a capacity of at least 8 L (2 gal) maintained at a temperature of  $25 \pm 1^{\circ}\text{C}$  ( $77 \pm 2^{\circ}\text{F}$ ) and a depth approximately equal to or above the height of the bowl of the volumetric flask.

**d.1.f.** Standard sieves 4.75 mm (No. 4).

**d.2. Test Method.**

**d.2.a.** Sample Preparation: This test is conducted on that portion of aggregate passing the 4.75 mm (No. 4) sieve.

**d.2.a.1.** Select a portion of the aggregate by splitting or quartering as established in **KT-1**. The portion selected should be of sufficient size to yield a sample weighing approximately 1,000 g all of which passes the 4.75 mm (No. 4) sieve.

**d.2.a.2.** Screen the portion selected over the 4.75 mm (No. 4) sieve and discard all material retained on that sieve.

**d.2.a.3.** Wash the minus 4.75 mm (No. 4) material [material passing the 4.75 mm (No. 4) sieve] over the 150  $\mu\text{m}$  (No. 100) sieve to remove dust.

**d.2.a.4.** Dry the plus 150  $\mu\text{m}$  (No. 100) material [material retained on the 150  $\mu\text{m}$  (No. 100) sieve] to a constant mass in the oven<sup>b</sup>.

**d.2.b. Procedure.**

**d.2.b.1.** Immerse the sample in water and stir vigorously. Soak for a period of  $24 \pm 4$  hours.

**d.2.b.2.** Remove the sample from the water and bring it to a saturated surface-dry condition<sup>4</sup>. The procedure to be used to obtain the surface-dry condition is as follows:

**d.2.b.2.a.** Place the saturated sample in a drying pan and allow to dry in air for a short time. Stir the sample regularly to ensure uniform drying.

**d.2.b.2.b.** Transfer the sample to another drying pan which has a slightly rusted bottom.

**d.2.b.2.c.** Stir the sample and check for the presence of free moisture<sup>c</sup> as indicated by a change of color of the surface of the bottom of the pan.

**NOTE c:** The first check should be conducted when there is some free moisture on the surface of the aggregate particles to ensure that a surface-dry condition has not been passed.

**d.2.b.2.d.** Stir the sample regularly and transfer it frequently from pan to pan until a saturated surface-dry condition is reached as indicated by the absence of free moisture on the bottom of the pan. All pans used should be slightly rusted to aid in detecting the presence of free moisture in the sample.

**d.2.b.3.** Immediately split out and weigh a sample of the saturated surface-dry material weigh not less than 500 g. Place the sample in the flask.

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<sup>4</sup> AASHTO T 84 **6.2.1** uses the cone test for determining SSD condition. Under **NOTE 2 (2)** Provisional Surface Test, the use of “a worn oxidized” surface is permitted and represents the method presented in **d.2.b.**

**d.2.b.4.** Fill the flask to a level slightly below the calibration mark with water at a temperature of  $25 \pm 1^{\circ}\text{C}$  ( $77 \pm 2^{\circ}\text{F}$ ).

**d.2.b.5.** Rotate the flask in an inclined position to eliminate all air bubbles<sup>d</sup>.

**NOTE d:** Bubbles or foam may be dispelled by touching them carefully with a hot wire.

**d.2.b.6.** Place the flask in the water bath until the temperature of the material inside the flask is the same as that of the water bath.

**d.2.b.7.** Fill the flask to the calibration mark, remove from the water bath and wipe all moisture from the outside surface

**d.2.b.8.** Weigh the flask and its contents to the nearest 0.1 g.

**d.2.b.9.** Remove the aggregate from the flask and dry to a constant mass in the oven at a temperature of  $110 \pm 5^{\circ}\text{C}$  ( $230 \pm 9^{\circ}\text{F}$ ).

**d.2.b.10.** Cool the sample to room temperature and weigh.

### **d.3. Calculations.**

**d.3.a.**  $W = K - (F+B)$

**d.3.b.** Bulk Specific Gravity = 
$$\frac{A}{V-W}$$

**d.3.c.** Bulk Specific Gravity (Saturated Surface-dry Basis) = 
$$\frac{B}{V-W}$$

**d.3.d.** Apparent Specific Gravity = 
$$\frac{A}{(V-W)-(B-A)}$$

**d.3.e.** Absorption (%) = 
$$\frac{100 (B-A)}{A}$$

Where: W = Mass of water added to the flask, g  
F = Mass of empty flask, g  
K = Mass of flask, plus sample, plus water (See step **d.2.b.8.** above), g  
A = Mass of oven-dry sample in air, g  
B = Mass of saturated surface-dry sample in air, g  
V = Volume in mL of flask.

## e. REPORT

**e.1.** Report all specific gravities to the nearest 0.001 and indicate the type of specific gravity. Report the absorption result to the nearest 0.1 percent.

## f. PRECISION

**f.1.** The estimates of precision of this test method (listed in Table 5.16.06-2) are based on results from the AASHTO Materials Reference Laboratory Reference Sample Program with testing conducted by AASHTO, T 84 and T 85, and ASTM, C 128 and C 670. The significant difference between the methods is that ASTM requires a saturation period of  $24 \pm 4$  hours, and AASHTO requires a saturation period of 15 to 19 hours. This difference has been found to have an insignificant effect on the precision indices.

Table 5.16.06-2 Precision for Specific Gravities and Absorption of Aggregates						
Coarse Aggregate			Fine Aggregate			
Single Operator Precision	1S	D2S	Single Operator Precision	1S	D2S	
Bulk Specific Gravity (Dry)	0.009	0.025	Bulk Specific Gravity (Dry)	0.011	0.032	
Bulk Specific Gravity (SSD)	0.007	0.020	Bulk Specific Gravity (SSD)	0.0095	0.027	
App. Specific Gravity	0.007	0.020	App. Specific Gravity	0.0095	0.027	
Absorption percent	0.088	0.25	Absorption percent	0.11	0.31	
Multilaboratory Precision	1S	D2S	Multilaboratory Precision	1S	D2S	
Bulk Specific Gravity (Dry)	0.013	0.038	Bulk Specific Gravity (Dry)	0.023	0.066	
Bulk Specific Gravity (SSD)	0.011	0.032	Bulk Specific Gravity (SSD)	0.020	0.056	
App. Specific Gravity	0.011	0.032	App. Specific Gravity	0.020	0.056	
Absorption percent	0.145	0.41	Absorption percent	0.23	0.66	

**g. ADDENDUM - SUPPLEMENTAL CALCULATIONS TO COMBINE AGGREGATE ABSORPTION**

**g.1.** In a few special cases the specifications have an absorption requirement on each individual source. Procedures I and II are both used and the combined aggregate absorption must be calculated. (This calculation is not to be used when the specifications have an absorption requirement by Procedure I and/or Procedure II.

**g.2.** Absorption of the individual source equals:

$$\text{Combined Absorption, } A_{co} (\%) = \frac{(\text{Abs}_c)(\%C) + (\text{Abs}_f)(\%I)}{100}$$

Where:  $A_{co}$  = Combined Absorption, %  
 $\text{Abs}_c$  = Absorption, Proc. I, %  
 $\text{Abs}_f$  = Absorption, Proc. II, %  
 $\%C$  = Percent plus 4.75 mm (No. 4) in each individual source.  
 $\%I$  = Percent minus 4.75 mm (No. 4) in each individual source.